Operations IPT System Architecture & Mission Concepts Update, 5/1/96

The March, 1996 material on these same subjects received further discussion and some changes--as was to be expected. This note documents the revisions and the IPT's approach to developing its NGST Operations Systems study.

We received comments from ATSC and Hughes, STX. Some of these dealt with the mission concepts. Most got at least one level into the data system architecture with potential answers. Evidently, the original note was not clear enough as to its goal--which was an attempt to draw and write down the elements of an NGST operations architecture that we could parcel out among IPT members (in "chunks") for elucidation, trade identification and iteration. Nevertheless, the comments were useful and will not be overlooked. If fact, our subsequent assignment of "leads" to the six major groupings of our operations systems architecture kicks off the effort of getting at and trading among design alternatives. Our group leads are looking for and will welcome the participation of everyone interested in NGST. Just give the following people a call or message and offer your support. (See the IPT's 4/25 meeting package on the Web for more info.)

Lead Individuals for Major Architectural Groups:

On-Board Processing	**Lou Hallock**	**301-286-4863**
Space/Ground Communications	**Steve Tompkins**	**301-286-6791**
Mission Operations	**Jack Leibee**	**301-286-9728**
Planning and Scheduling	**Larry Petro**	**410-338-4501**
Data Processing and Storage	**Rodger Doxsey**	**410-338-4750**
System Infrastructure	**Larry Dunham**	**301-805-4545**

Since raw data volume is a key to some of the trades the IPT must develop, there have been recent discussions about and some progress made toward assembling a design reference mission (DRM) science program. **Ted Gull (301-286-6184) is coordinating DRM definition for the IPT**, and Peter Stockman is offering up a strawman in order to obtain comments from the science community. You'll see more about this on the Web soon. As the concept for the NGST Science Module is further refined, it will become possible to converge on a better estimate of the data volume the spacecraft and ground must handle.

High-Level Mission Concepts

As the baselined L2 orbit for NGST is compatible with each of our earlier-proposed "mission concepts" we will carry them forward until we can better discriminate among them. (Downlink data volume may eventually be a primary factor in ranking them.) These alternative concepts are repeated below, with a few changes. During the IPT's discussion, Les Deutsch proposed an additional concept which has been added to the study space. We will compare and contrast functional architectures for these mission concepts. These comparisons will provide the larger NGST community with distinct choices.

The mission concepts are:

1. A mission governed by stored program commands (SPCs) periodically uplinked to the spacecraft. A downlink (ROM 1 Mbps, but TBD) is available (and used) nearly continuously.

2. A mission governed by SPCs periodically uplinked to the spacecraft. A higher rate downlink (ROM 10 Mbps, but TBD) is available and used for periodic, burst-mode

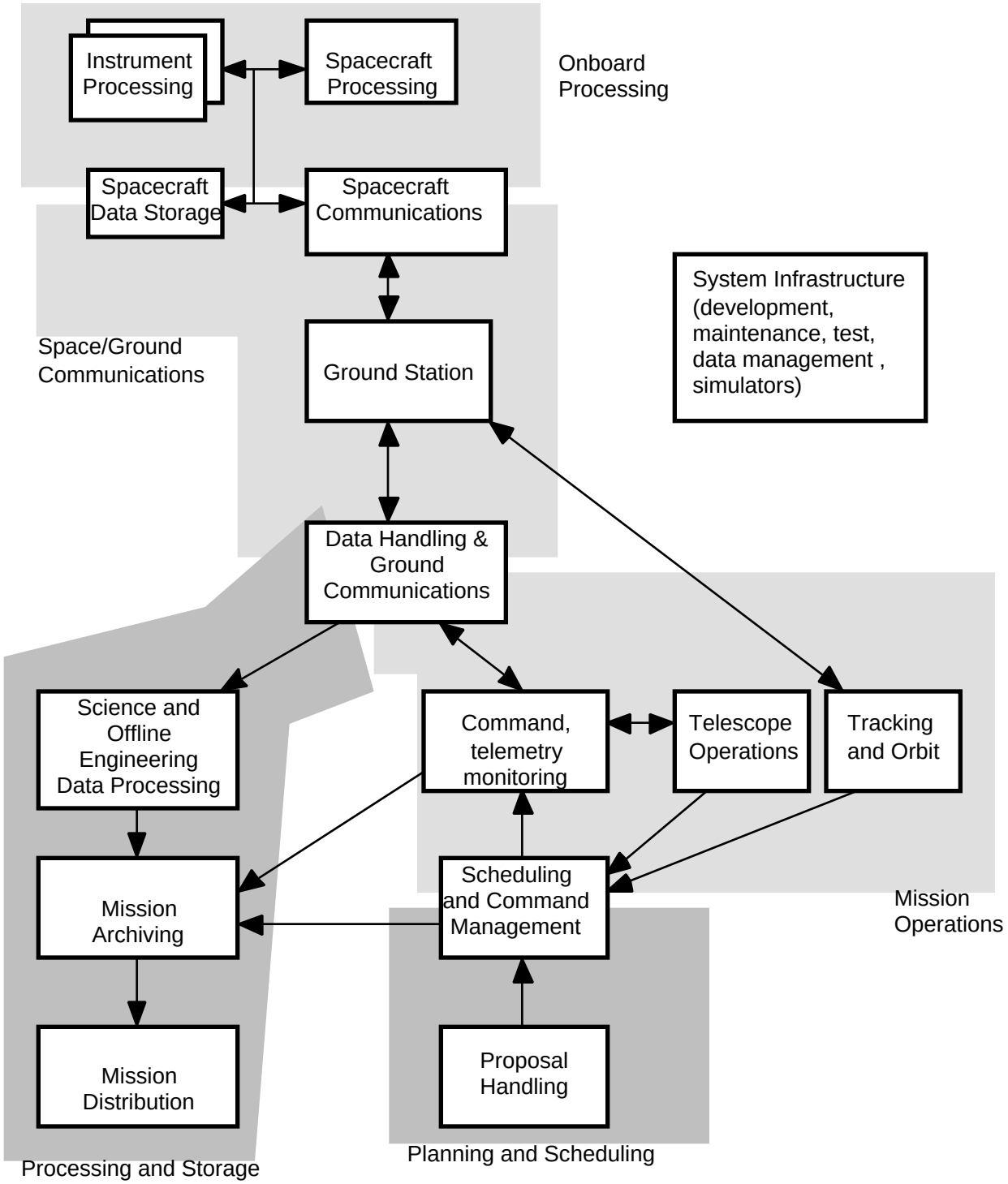
transmission of data to the ground. Sub-options for engineering telemetry are: a) burst transmission of a full telemetry record or windowed subset temporarily stored on-board, b) continuous low-rate downlink of a small telemetry subset or beacon-mode signal, or c) some combination of a) and b), perhaps using b) as a trigger for a). The continuous low-rate downlink may also support some degree of real-time interaction enabled by ground receipt of a science data subset.

3. A mission controlled in real-time only (*a.k.a.* , "IUE mode") with block scheduling of guest observer time allocations and support for an "observer at home" remote interface. ("Observatory science", e.g., systemmatic surveys could still be handled by NGST staff.) The downlink rate is again ROM 1 Mbps (TBD).

4. A mission controlled by users via an assignable, distributed operations node. Time would be allocated to users by automated scheduling system that knows about temporal priorities. During an assigned block of time, the user would "operate" NGST using a very high-level command language that would provide an interface that is both safe to the spacecraft and easy for the user to use. The basic commands would be things like: "point to location, "acquire target" (with user-specified acquisition metrics), "chose instruments" (configures the detectors, including filters and integration algorithms), "get snapshot" (returns an image from the chosen detectors in real-time), and so forth. Time would also be allocated for (largely automated) engineering maintenance of the spacecraft and for instrument calibration.

While this last concept is readily seen as an extension of "IUE Mode" we will also explore it in SPC scenarios. This kind of user interface might support infrequent real-time interaction and short response times for targets of opportunity. It might also permit the deadline for specification of "routine" autonomously executed observations to be set only days before their uplink in a command load.

NGST Data System Functional Architecture



4/17/96

The NGST Data system Functional Architecture is intended to be a generic architecture that can be used to support the Operations IPT efforts without presuming a particular solution. It was developed with some assumptions in mind (for example, L2 orbit, preplanned proposal driven mission) but it is hoped that this architecture could be adapted to other mission concepts without significant modifications.

The functions could be combined or distributed. In particular, many of the ground system functions could be performed at least in part onboard in the spacecraft or instrument processing function.

Instrument Processing. Includes all functions performed within the instruments - data compression, data formatting, target acquisition, peak-up, macro command expansion, buffering, attitude determination support, instrument housekeeping data monitoring, instrument safemode, instrument autonomous functions.

Spacecraft processing. Stored command processing (absolute time and relative time). Attitude and position determination. Data formatting. Housekeeping data monitoring. Safe mode. Onboard autonomy. This function also includes any processing required to operate and calibrate the telescope.

Spacecraft data storage. Records and/or buffers data for downlink.

Spacecraft communications. RF communications with the ground and implements the onboard portions of any space/ground protocol.

Ground Station. RF communications with the spacecraft.

Data Handling and ground communications. Moves the data from the applications onboard to the applications on the ground and vice versa. May be performed by the protocol.

Command, Telemetry monitoring. Generates commands or directives for the spacecraft and instruments and monitors their real time telemetry. May be distributed. This function is also used to perform the integration and test of the spacecraft prior to launch.

Telescope operation. Monitors the telescope configuration and calibration. Establishes and maintains the phasing of the optics. In some ops concepts, it oversees the maneuvers and target acquisitions. This function could be distributed.

Scheduling and command management. Schedules the observations, the contacts with the ground station, any housekeeping/engineering activities, including calibrations, checks for constraints, distributes schedules to all components, generates command loads.

Proposal management. Accepts and formats proposals and tracks them through the system.

Science and offline engineering data processing. Processes the outputs of the instruments (along with ancillary data) into science products. Performs engineering analysis of spacecraft and instrument telemetry parameters.

Mission archiving. Permanent storage of NGST products. May include archived plans, operations history, and engineering data as well as science products.

Mission Distribution. Distribution of data to users.

Tracking and Orbit. All orbit functions including orbit determination, orbit prediction, and maneuver planning.

System Infrastructure. Development systems, maintenance systems (including flight software maintenance), test systems, simulators, and supporting data repositories (e.g., project data base, documentation).

These functions (other than the system infrastructure) can be chunked into 5 larger groupings. Note that some functions appear in more than 1 grouping.

Onboard Processing. Includes the instrument processing, the spacecraft processing, the spacecraft communications, and the spacecraft data storage.

Space/Ground Communications. Includes the Spacecraft data storage, the spacecraft communications, the ground stations and the data handling and ground communications function.

Science Processing. Includes the Data handling and ground communications, the science data processing, the mission data archiving and the mission data distribution functions.

Planning and scheduling. Includes proposal management and scheduling and command management function.

Mission Operations. Includes the command and telemetry monitoring, the tracking and orbit, telescope operations, the data handling and ground communications, and the scheduling and command management functions.